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No. 168

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GRADES FOR COMMERCIAL CORN.

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CLASSIFICATION OF CORN.

By virtue of the authority vested in the Secretary of Agriculture by the acts of Congress of June 30, 1906 (34 Stat., 669), and of March 4, 1913 (37 Stat., 828), to fix definite grades of grain, the grades for corn shown in Table I were fixed and promulgated on January 3, 1914, to take effect on July 1, 1914.

TABLE I.—*Grade classification of white, yellow, and mixed corn, showing maximum allowances of moisture and other factors.*

Grade classification.	Maximum allowances of—			
	Moisture.	Damaged corn.	Foreign material, including dirt, cob, other grains, finely broken corn, etc.	"Cracked" corn, not including finely broken corn. (See general rule No. 9.)
	Per cent.		*Per cent.*	*Per cent.*
No. 1	14.0	2 per cent (exclusive of heat-damaged or mahogany kernels)	1	2
No. 2	15.5	4 per cent (exclusive of heat-damaged or mahogany kernels)	1	3
No. 3	17.5	6 per cent (exclusive of heat-damaged or mahogany kernels)	2	4
No. 4	19.5	8 per cent (may include heat-damaged or mahogany kernels not to exceed one-half of 1 per cent)	2	4
No. 5	21.5	10 per cent (may include heat-damaged or mahogany kernels not to exceed 1 per cent)	3	5
No. 6	23.0	15 per cent (may include heat-damaged or mahogany kernels not to exceed 3 per cent)	5	7
Sample		See general rule No. 6 for sample grade		

GENERAL RULES.

(1) The corn in grades No. 1 to No. 5, inclusive, must be sweet.

(2) White corn, all grades, shall be at least 98 per cent white.

(3) Yellow corn, all grades, shall be at least 95 per cent yellow.

(4) Mixed corn, all grades, shall include corn of various colors not coming within the limits for color as provided for under white or yellow corn.

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(5) In addition to the various limits indicated, No. 6 corn may be musty, sour, and may also include that of inferior quality, such as immature and badly blistered corn.

(6) All corn that does not meet the requirements of either of the six numerical grades by reason of an excessive percentage of moisture, damaged kernels, foreign matter, or "cracked" corn, or corn that is hot, heat damaged, fire burnt, infested with live weevils, or otherwise of distinctly low quality shall be classed as sample grade.

(7) In No. 6 and sample grades, the reasons for so grading shall be stated on the inspector's certificate.

(8) Finely broken corn shall include all broken particles of corn that will pass through a metal sieve perforated with round holes nine sixty-fourths of an inch in diameter.

(9) "Cracked" corn shall include all coarsely broken pieces of kernels that will pass through a metal sieve perforated with round holes one-quarter of an inch in diameter, except that the finely broken corn, as provided for under rule No. 8, shall not be considered as "cracked" corn.

(10) It is understood that the damaged corn, the foreign material (including dirt, pieces of cob, finely broken corn, other grains, etc.), and the coarsely broken or "cracked" corn, as provided for under the various grades, shall be such as occur naturally in corn when handled under good commercial conditions.

(11) Moisture percentages, as provided for in these grade specifications, shall conform to results obtained by the standard method and tester described in Circular No. 72, Bureau of Plant Industry, U. S. Department of Agriculture.

HOW THE VARIOUS FACTORS SHOULD BE DETERMINED.

In order that producers, dealers, and consumers throughout the United States may fully understand the correct interpretation of the Government corn grades, somewhat detailed explanations are given in the following pages.

In the practical application of these grades it is fully appreciated that even with definite limits for the more important factors points will arise on which the best of experts may differ. For example, there are all degrees of damage and wide variations in color, so that some arbitrary line must be drawn as to what shall be considered as commercially sound or what shall be considered as white or as yellow. Similar conditions exist on other points. It is believed, however, that by the honest adherence to the instructions which follow differences in grading will be reduced to a minimum and that the grades can be uniformly applied throughout the United States.

While these explanations are given somewhat in detail and definite limits have been fixed for the more important factors, it is not contemplated that actual determinations shall be made in the grading of every lot of commercial corn. In a large number of cases a competent and experienced inspector or grader, after he has once become familiar with the various limits fixed and established in these grades, can estimate the percentage of the various factors with sufficient accuracy to determine the grade thereof on the basis of his judgment.

SECURING A REPRESENTATIVE SAMPLE FROM THE BULK.

In the grading of commercial corn no factor is of greater importance than the securing of a sample representative of the bulk. Likewise, no factor is more frequently neglected. In the application of these grades to car-lot shipments of corn it is recommended that not less than five probes with a suitable grain trier be taken in such a way that the composite sample thus secured will represent the average of the car as nearly as practicable. On cars not uniformly loaded, such additional probes should be made as, in the opinion of the sampler, may be necessary to secure a representative sample. In cars that show distinct evidence of having been "plugged," and in all cases of marked variation in the quality or condition of the corn in different parts of the lot being examined, a separate composite sample should be taken to represent each such portion.

If only a part of the grain secured by the various probes is taken to a central office for more careful examination and final grading, the mixing of the individual sample at the car should receive most careful consideration. Very satisfactory results can be secured by emptying the contents of the trier each time on a piece of canvas and, after all probes have been made, thoroughly mixing the samples on the canvas, finally rolling the sample on the canvas, somewhat as an expert would roll a cigarette, except that the canvas should be held by two opposite sides, which two sides should be securely fastened to a stick or rod. The larger composite sample can then be readily divided into two approximately equal parts by seizing the fold of the canvas from beneath with the thumb and index finger; then, emptying one portion into the car, the other is retained for the office sample.

Representative samples can not be secured by emptying the contents of the trier, after each probe, on top of the grain, then roughly mixing and taking a portion thereof, usually including a part of the surface corn, as a composite sample for the basis of grading. Such samples not only fail to represent the bulk, but are misleading, especially from the standpoint of dirt and cracked corn. Likewise, composite samples made up by emptying only a part of the contents of the trier into the can or sample bag can not, as a rule, be considered representative.

In the sampling of large lots of grain, such as occur in the loading of steamers, at least one representative sample made up of a series of samples from the various drafts should be taken for each 5,000 bushels.

In the sampling of ear corn, where the moisture content is the important factor, at least 20 representative ears should be taken at random for each 1,000 bushels. In wagon lots of 100 bushels or

less, at least 10 representative ears should be selected for test. In all ear-corn samples where it is impracticable to shell completely all of the selected ears, an approximately equal portion should be shelled from the same point or points on each ear. A simple and satisfactory method is to break the ears near the middle and then shell from the broken ends. In ear corn the damage can usually be very closely estimated by classifying a limited number of ears, but for a more exact determination it will be necessary to shell the selected number of ears completely and determine the percentage of damaged kernels in the regular manner.

MIXING SAMPLES FOR DETAILED ANALYSES.

Care should be taken to see that the samples used for the detailed analyses are representative of the larger sample as drawn from the car or other bulk.

A special sampling or mixing machine for this purpose has been developed. This mixing machine will be described in detail in a later bulletin of the Department of Agriculture.

SIZE OF SAMPLES.

The samples taken from the car or other bulk on which the grading is to be based should consist of not less than 1 quart of shelled corn.

The samples for the more detailed analyses, taken from the larger sample representing the bulk, should be as follows:

Moisture content.—100 grams for each single test.

Color.—Not less than 100 grams of screened corn.

"Cracked" corn and foreign material, dirt, etc.—At least 200 grams of the carefully mixed sample. In using a 200-gram sample it must be remembered that the weight in grams of each of the two factors must be divided by 2 to ascertain the percentage.

Damaged corn.—Preferably, on the whole of what remains of the sample after removing the cracked corn, the foreign material, dirt, etc. In this connection it should be remembered that the percentage of damaged corn should be based not on the weight of the screened sample but on the weight of the sample taken for analysis before removing the cracked corn, the foreign material, dirt, etc. For example, in a 200-gram sample showing 3 per cent of cracked corn and 2 per cent of foreign material, dirt, etc., there would remain 190 grams to be analyzed for damaged kernels. Damaged kernels weighing 20 grams based on the original 200-gram sample would therefore be equivalent to 10 per cent, whereas if incorrectly based on only 190 grams the percentage of dirt would show as 10.4 per cent.

SIEVES FOR SCREENING SAMPLES.

The sieves for screening the samples should be made of metal perforated with round holes. The holes in the upper or first sieve should be one-quarter of an inch in diameter and the holes in the lower or second sieve nine sixty-fourths of an inch in diameter. Figures 1 and 2 show these holes of natural size and the approximate

distance from center to center. The thickness of the metal should be from 0.025 to 0.035 of an inch.

Round sieves from 10 to 12 inches in diameter or rectangular sieves 9 by 11 inches have been found very satisfactory and easy to manipulate. For the most efficient work, the two sieves with the bottom pan should be made to nest, so that all screening can be done at one operation.

It is recommended that the sieves be made of brass, aluminum, or other suitable metal, pressed from one piece, although sieves made by soldering or nailing the perforated metal to any suitable frame will give satisfactory results if kept in good repair.

If made to nest, as shown in figure 3, the depth of the first sieve should be 1½ inches, the second 2 inches, and the bottom pan 2½ inches.

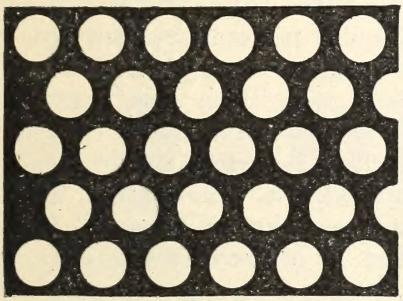

FIG. 1.—Section of sieve with perforations one-fourth of an inch in diameter, the distance from center to center of holes being approximately eleven thirty-seconds of an inch.

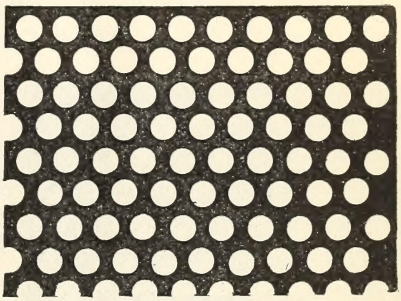

FIG. 2.—Section of sieve with perforations nine sixty-fourths of an inch in diameter, the distance from center to center of holes being approximately thirteen sixty-fourths of an inch.

If made of metal, at least the bottom pan should be of aluminum, to reduce the weight, thereby facilitating the ease of handling.

MOISTURE TESTS.

In determining the moisture content, it is desirable that all important samples be tested in duplicate whenever practicable and the final result based on the average of the two tests. Results of tests need not be expressed closer than one-tenth of 1 per cent, and the grain should be given the benefit of the doubt in computing averages. For example, in taking the average of two tests, one showing 19.3 per cent and the other 19.4 per cent, the true average would be 19.35 per cent, but when used in connection with these grades the moisture content should be recorded as 19.3 per cent and not 19.35 per cent. Likewise, in single tests any reading in the second decimal place may be ignored in moisture determinations.

Owing to the numerous methods of making moisture determinations and the wide variations in the results obtained by the different methods, the tester and method described in Circular No. 72 of the

Bureau of Plant Industry, United States Department of Agriculture, have been designated as the standard on which the grades have been based. Copies of this circular can be secured upon application to the United States Department of Agriculture. This in no way precludes the use of other methods of making moisture determinations, so long as the results are corrected to conform to those secured by the standard method specified. Figure 4 represents a sectional view of the standard tester that is recommended. The United States patent covering this tester has been donated to the people of the United States, so that the tester can be used, manufactured, or sold by any citizen within the United States without the payment of royalty.

DAMAGED CORN.

As shown in the grade classification (Table I), the grades 1, 2, and 3 may contain not to exceed 2, 4, and 6 per cent, respectively, of damaged corn, such as "cob-rotten" corn, "blue eyes," etc., but these first three grades shall not include heat-damaged or mahogany kernels. Grades 4, 5, and 6 may contain not to exceed 8, 10, and 15 per cent, respectively, of damaged corn, a portion of which may consist of heat-damaged or mahogany kernels. The heat-damaged or mahogany kernels permissible as a part of the damaged corn shall not exceed one-half of 1 per cent in No. 4 grade, 1 per cent in No. 5 grade, and 3 per cent in No. 6 grade; but the total damaged in these three grades shall not exceed 8, 10, and 15 per cent, respectively.

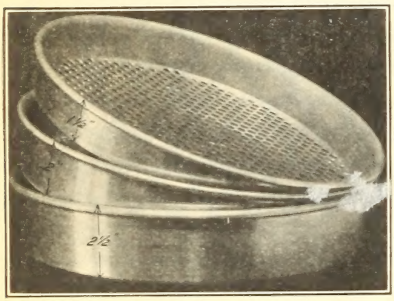

FIG. 3.—Nest of two sieves and bottom pan used in grading corn.

Types of damaged kernels.—An attempt has been made to show in natural colors by means of kernels numbered 1 to 26 in Plate I types of kernels which should be classed as damaged. These types of damage range from the badly "silk-cut" kernels, shown in No. 1 (front and back of same kernel), to the very badly "cob-rotten" kernels shown in No. 26. These types also include badly shriveled kernels which have failed to ripen (shown by kernels numbered 14 and 15). However, skeleton kernels similar to this type, when consisting of nothing but the skin of the kernel or of such a character that they would be removed by light blowing or fanning, should be classed as foreign material and not as damaged corn. Types of such skeleton kernels are shown in figure 5.

TYPES OF COLOR

TYPES OF DAMAGE

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TYPES OF KERNELS OF CORN FOR USE IN GRADING.

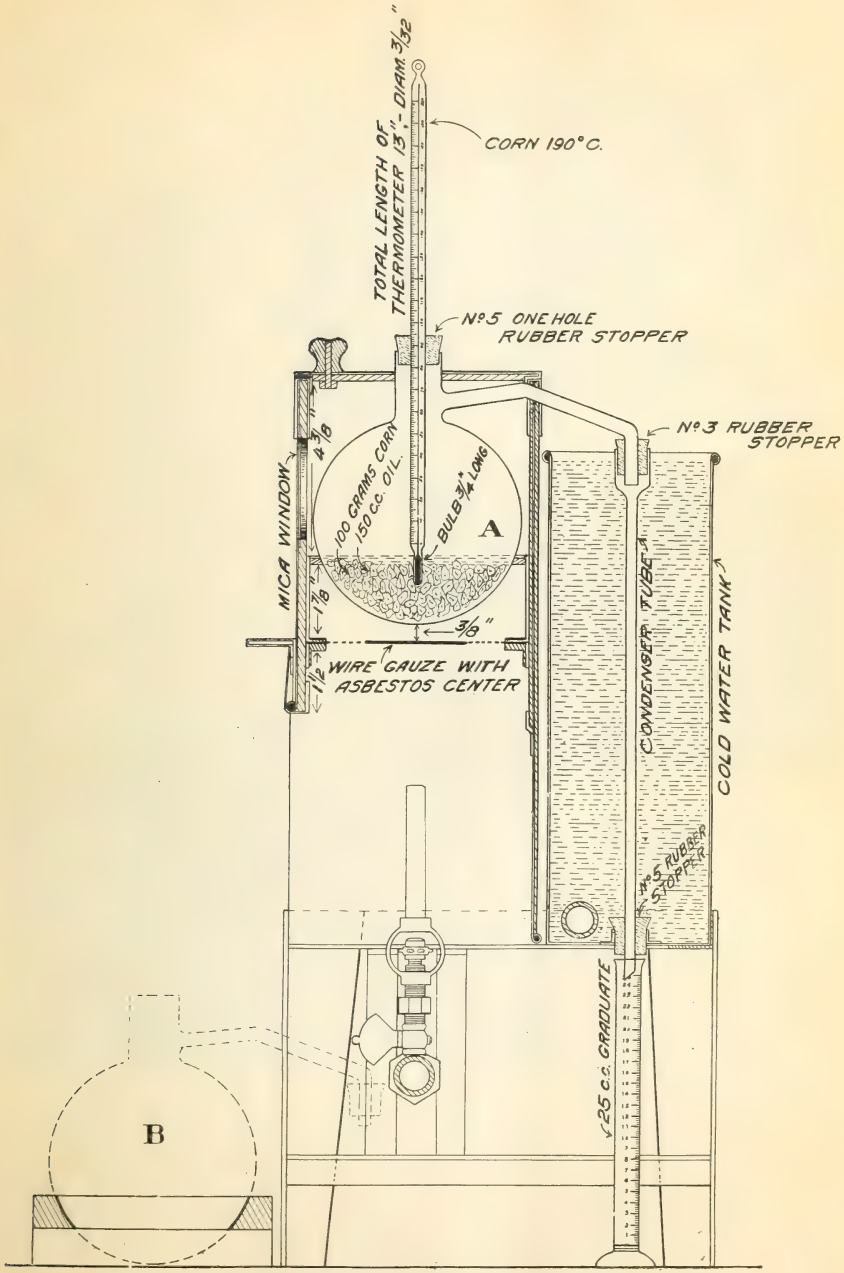

FIG. 4.—Sectional view of standard moisture tester.

Heat-damaged and mahogany kernels.—Corn which has become discolored as a result of heating due to fermentation or fire damage shall be classed as "heat damaged." Badly discolored and darkened kernels shall be classed as "mahogany" corn. No heat-damaged kernels are shown in the colored plate.

DETERMINATION OF DAMAGED CORN.

The percentage of damage should be made on the screened sample, preferably by using the entire quantity that remains after removing the foreign material and "cracked" corn. In order to simplify the determination for damaged corn and to avoid a double penalty, the damaged "cracked" corn, as used in these grades, shall be considered simply as "cracked" corn; that is, the small quantity of damaged "cracked" corn should not be picked out after screening and classified as a part of the damaged corn. An excess of damage in the "cracked" corn will be evidence of a willful adulteration and a violation of general rule No. 10 of the grades.

FIG. 5.—Immature skeleton kernels which would be removed by fanning or blowing and should therefore be classified as foreign material. (Natural size.)

FOREIGN MATERIAL.

The foreign material, including dirt, pieces of cob, other grains, finely broken corn, etc., as provided for in column 4 of Table I, should include not only material that will pass through the sieve with holes nine sixty-fourths of an inch in diameter, as shown in figure 6, but should also include the coarser foreign material, such as is shown in figure 7. It will be found after a little experience that the coarse material shown in figure 7 can be taken out very quickly by hand picking after the finer material has been removed by screening, whenever such hand picking is necessary to determine correctly the grade of the grain in question.

CRACKED CORN.

As provided for in general rule No. 9, all coarsely broken pieces of kernels that will pass through the metal sieve perforated with round holes one-quarter of an inch in diameter (first sieve) and are retained on the sieve with the smaller perforations (second sieve) shall be considered as "cracked" corn, as shown in figure 8. More-

over, this is the only broken corn which should be so classified in these grades. The finely broken pieces which will pass through the sieve with the smaller perforations should be classed with the foreign material, and the large pieces which remain on the sieve with the quarter-inch holes should be classed with the whole kernels.

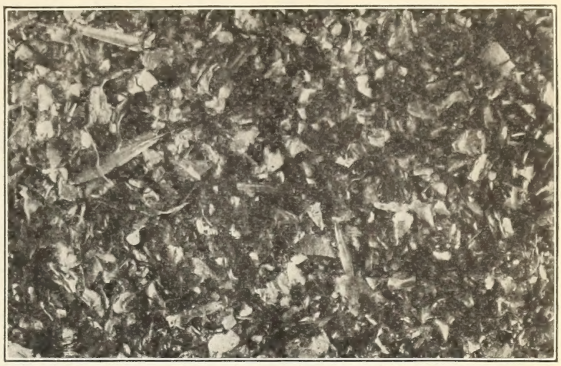

FIG. 6.—Foreign material, including dirt, chaff, other grains, finely broken corn, etc., which will pass through the sieve with the smaller perforations, nine sixty-fourths of an inch in diameter. (Natural size.)

However, it is not intended that all material remaining on the sieve with the smaller holes shall be classed as "cracked" corn. All small whole kernels, such as those that are shown in figure 9, which will go through the sieve with the quarter-inch holes should be picked out after screening and classed as whole corn. Likewise, any "other grains," pieces of cob, or other foreign material remaining with the "cracked" corn on the sieve with the smaller holes should be picked out and added to the foreign material, dirt, etc. In applying these grades, no separation should be made of the sound and the damaged "cracked" corn, but the whole should be classed only as "cracked" corn.

FIG. 7.—Coarse material, which will not pass through the sieve with the smaller perforations, nine sixty-fourths of an inch in diameter, but which should be picked out of the sample and included with the foreign material, dirt, cob, other grains, etc. (Natural size.)

COLOR.

Color determinations should be made on not less than 100 grams of the screened sample; that is, after the "cracked" corn and foreign material have been removed. All grades of white corn require that at least 98 per cent, by weight, shall be white, as stated in general rule No. 2, and all grades of yellow corn require that at least 95 per cent shall be yellow, as provided in general rule No. 3. In most

cases, when examining white corn it will not be necessary to make weighings unless there are more than 5 kernels of corn of other colors, and on yellow corn, unless there are more than 12 kernels of

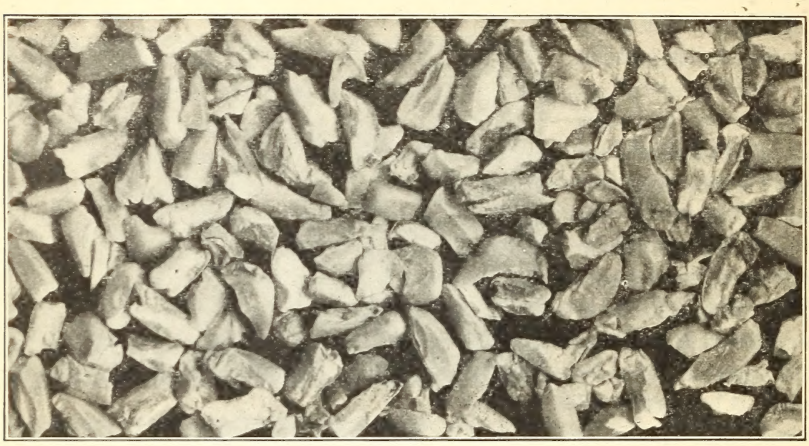

FIG. 8.—"Cracked" corn, consisting of pieces of kernels which will pass through the sieve with the quarter-inch perforations. (Natural size.)

other colors, in a 100-gram sample, as 5 kernels will usually be less than 2 per cent and 12 kernels less than 5 per cent.

More difficult problems arise, however, in dealing with special types or varieties of corn or with individual kernels, such as "straw-

FIG. 9.—Small whole kernels which will pass through the sieve with the quarter-inch perforations, but which should not be classed as "cracked" corn. (Natural size.)

colored," "red-cast" yellow, etc., which are difficult to classify. At most, such classifications can be only arbitrary and in keeping with the best commercial practices. In order to bring about the greatest uniformity of application, some of the more important types of kernels from the standpoint of color are shown in Plate I in natural

colors, as nearly as it is possible to reproduce them. Kernels numbered 1 to 9, inclusive, under types of color, have been classified as white corn. It will be noted that some of the kernels at the right in this first series are of a very light straw color, but not sufficient to justify their being classed as of other colors when found in a grade of white corn. Kernels with a tinge of pink over white (not shown in the plate) should be considered on the same basis as straw-colored kernels; that is, where the pink color is only very slight they may be classed as white; otherwise they should be eliminated. In kernel No. 10, however, the yellow color is more pronounced, and such kernels should not be classed as either white or yellow corn. The same is true with all kernels numbered 10 to 18, inclusive. Kernels numbered 10 to 14, inclusive, are intended to represent white-capped pale yellow, kernel No. 19 represents a pale yellow of the lowest type, and kernel No. 27 represents a "red-cast" yellow of the most pronounced type which should be classed as yellow corn.

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